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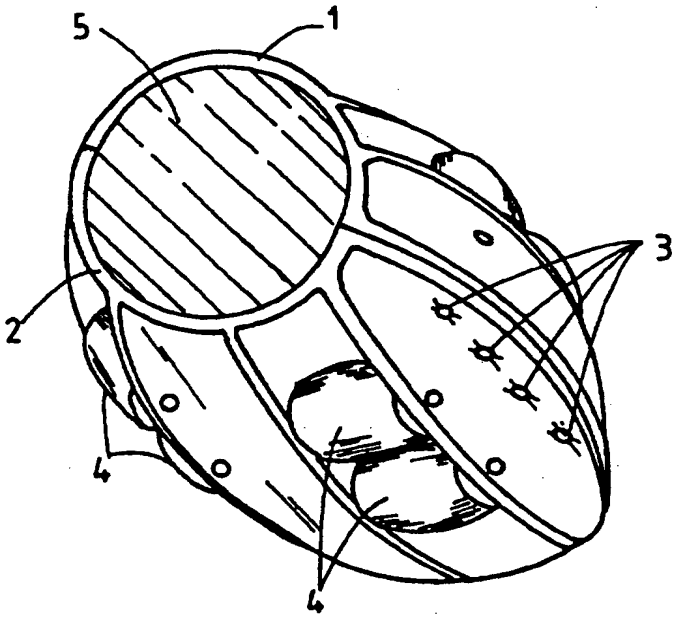
(54) Title: DRILL STRING FITTING

(57) Abstract

A fitting for reducing friction between a drilling string and the wall of a well. In a first aspect the fitting has recesses (6) provided along the bore of the fitting to lubricate the interface between the fitting and the drill string to minimise friction. In a second aspect a fitting is provided on a drill string having rotatable roller means (21) which can rotate about a point of rotation (23) so as to minimise both axial and rotational friction. According to a third aspect the fitting comprises an inner section (30) secured to a drill pipe (35) or other fitting and an outer section (31) rotatable about the inner section (30). Preferably a sealed bearing (36, 42-47, 37, 38) is provided between the inner section (30) and outer section (31).



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DRILL STRING FITTING

Technical Field

The present invention relates to a fitting for reducing friction between a drill string and the wall of a well. More particularly, but not exclusively, in a first aspect the present invention relates to a fitting having a plurality of longitudinal recesses enabling lubrication between the fitting and a drill string using drilling fluid. According to a second aspect there is provided a fitting having rotatable rollers to reduce both axial and rotational friction. According to a third aspect there is provided a fitting having an outer section rotatable relative to an inner section secured about a drill string.

Background of the invention

The depth to which and angle at which a well can be drilled are often limited by the degree of friction experienced by the drill string. The life of a drill string may also be reduced due to friction. With increasing environmental concerns it is also becoming less acceptable to reduce friction by injecting chemicals down a well. Using wellstream fluids as a lubricant results in drill string wear due to particulate matter carried in the fluids. Further, currently available similar fittings cannot be rebuilt or reconditioned.

Disclosure of the invention

It is an object of the present invention to provide a fitting which reduces the friction on a drill string or at least to provide the public with a useful choice.

According to a first aspect of the invention there is provided a fitting for reducing friction between a fitting and a section of a drill string or further fitting on a drill string, said fitting comprising a body having a tubular bore provided with a plurality of longitudinally extending recesses spaced circumferentially about the bore, dimensioned to lubricate the interface between the fitting and the drill string or further fitting with fluid in a drilling well.

Preferably, the bore of the fitting has a polygonal cross-section. Preferably, a filtering means is provided at either end of the fitting to prevent the debris entering the longitudinal recesses.

The fitting may preferably be formed as a two part casing which can be secured to an assembled drill string. Preferably, rollers are provided on the outside of the fitting to reduce friction between the fitting and a wall of the well.

Preferably, the fitting will be secured to a sleeve having collars at either end which is securable to a section of drill pipe. In another embodiment the fittings may have a substantially circular cross-section and the sleeve may have a polygonal cross-section.

According to a further aspect of the invention there is provided a fitting for engagement to a drill string or further fitting having a body with a bore therethrough provided with a plurality of roller means on the exterior of the body, said roller means being rotatable relative to said fitting about an axis transverse to the axis of the bore, the arrangement being such that the roller means can

rotate relative to said body to facilitate reduction of rotational and axial friction.

Preferably, the rollers have a substantially tapered cylindrical form and rotate about an axis transverse to the axis of rotation of the roller means. The body may be of two part construction and the rollers are preferably formed of a nylon or ceramic material.

According to a further aspect of the invention there is provided a fitting for engagement with a drill string or further fitting comprising an inner section for securement about a drill string or further fitting and an outer section secured about said inner section and rotatable relative thereto.

Preferably a sealed bearing is provided between the inner and outer sections. Preferably a plurality of fins project radially from the outer section which are profiled to reduce drag in the axial direction.

Brief Description of the drawings

Further aspects of the invention will become apparent from the following description which is given by way of example of possible embodiments with reference to the accompanying drawings in which:

Figure 1: Shows a two part fitting having a polygonal bore.

Figure 2: Shows the interface between a drill string and the interior polygonal bore of the fitting shown in Figure 1.

Figure 3: Shows a section of drill string having collars at either end for receiving the fitting of Figure 1 therebetween.

Figure 4: Shows an end view of the fitting of Figure 1.

Figure 5: Shows an end view of the fitting of Figure 1 engaged with the sleeve shown in Figure 3.

Figure 6: Shows a front view of the fitting of Figure 1 showing a partial cross-sectional view.

Figure 7: Shows a fitting having rotatable rollers provided on the body thereof.

Figure 8: Shows a cross-sectional view of a rotatable roller shown in Figure 7.

Figure 9: Shows a cross-sectional view of a roller of a rotatable roller shown in Figure 7 or Figure 8.

Figure 10: Shows a perspective view of a fitting according to a third embodiment.

Figure 11: Shows a cross-sectional view along the axis of the fitting shown in figure 10.

Figure 12: Shows an enlarged view of the seal arrangement shown in figure 11.

Best mode for carrying out the invention

Referring firstly to Figures 1 to 6, there is shown a fitting for reducing friction on a pipe string. The fitting comprises a body formed of two parts 1 and 2 which may be secured together by bolts which pass through apertures 3. A plurality of rollers 4 are provided about the outside of the fitting to reduce longitudinal friction on the pipe string. The bore 5 of the body sections is polygonal so as to provide a number of longitudinal recesses 6 between the body 1 and a sleeve 7.

Drilling pipe is usually forged from high tensile steel. The outside surface is typically rough. The preferred method of securing the fitting of the invention to a drilling pipe is as follows. Firstly, a section of the drilling pipe is machined so as to have a relatively smooth outside surface. The two halves 7a and 7b of the sleeve shown in Figure 3 are then secured to the drilling pipe by bolts etc passing through the apertures of collars 8a, 8b, 9a and 9b. Once the sleeve has been secured to a section of pipe, the two halves 1 and 2 of the fitting are secured about sleeve portions 7a and 7b and secured by bolts passing through apertures 3.

Collars 8 and 9 restrict the longitudinal movement of the fitting. The fitting is however free to rotate about sleeve 7. Accordingly, friction due to rotation of the drilling rig is minimised due to the fluid lubricant provided in recesses 6 between body sections 1 and 2 and sleeve 7. Axial friction is reduced by rollers 4 which minimise friction between the wall of the well and the fitting in the longitudinal direction.

It would be possible to secure the fitting directly about a section of pipe. This would however not reduce friction to the same extent as by providing smooth sleeve 7. Where a new section of pipe is being manufactured, it may of course be provided with a smooth section having separate collars 8 and 9 integrally formed at either end thereof for receiving the fitting.

Although the interior bore 5 of the fitting has been described as polygonal, it will be appreciated that other shapes of internal bore (eg: sinusoidal) may be provided as long as suitable recesses are provided between the sleeves and the body of the fitting to minimise friction. In some applications the bore 5 of the fitting may be spiralled to minimise the effect of transitions from one recess to another and to promote fluid flow through the fitting. Filtering means, such as wire mesh may preferably be provided at either end of the fitting to prevent large debris entering the recesses.

In viewing Figure 5 it will be seen that each roller 4 is secured to body 1 by a pin 10 passing through roller 4. Pin 10 may pass through aperture 12 in body 1 into recess 11. The aperture 12 may then be welded closed to prevent the pin 10 be removed.

Roller 4 may preferably be formed of a ceramic or nylon material. Ceramic materials have the advantage that they exhibit excellent wear properties and have a low friction coefficient. Newly developed ceramics have acceptable "ductility" properties and are easily formed. Ceramics are also very stable at high temperatures and are self lubricating, so do not require oil-based lubrication. Ceramics materials are not susceptible to rheological failure or welding

either. One of the key advantages, however, is that the density of ceramic materials is such that if a roller breaks the pieces can be circulated out of the well bore, unlike steel fragments which sink to the bottom of the well and interfere with drilling.

As shown in Figure 6 a protective section 13 may be provided between the collars 8a, 8b and 9a, 9b and between the rollers 4 to create a smooth exterior profile so that parts of the fitting do not catch as the fitting is moved up and down in a well.

It is estimated that using fittings as herein before described about drill pipe joints will reduce the drag by at least 30%. This enables wells to be drilled to greater displacements and at higher angles. Further, expensive drill pipe is protected and the fitting is exposed to most of the wear. The fitting is designed for easy retrofitting to existing pipe and so avoids the need for large expenditure on new pipe strings.

Figures 7 to 9 show a second embodiment of the invention. The aim again is to reduce longitudinal and rotational friction on a pipe string or fittings employed therewith. A simple one part construction is described although it will be appreciated that a two part body as previously described, may be employed.

Body 20 is provided with a plurality of rotatable roller means 21, shown in more detail in Figure 8. Rotatable roller means 21 are substantially disc-shaped and have a cylindrical recess 22 located at the centre thereof. Pin 23 of body 20 engages in recess 22 so that the rotatable roller means 21 is rotatable about pin 23. Circumferential flange 24 is secured after roller means 21 has been inserted and

retains the roller means 21 in place in use. Circumferential flange 24 may be secured firmly in place by welding etc. The rotatable rollers 25 are secured off-centre from pin 23 so that the rotatable roller means 21 may be rotated as it is exposed to different types of frictional force (i.e. longitudinal or rotational).

From the above it will be apparent that when body 20 experiences pure rotation relative to the wall of a well, rollers 25 will not be able to rotate (in the position shown in Figure 7) and will cause the rotatable roller means 21 to rotate 90° so that the axes of the rollers are aligned with the axis of the drilling rig. When in this position, the rollers can freely rotate to minimise friction. When the drill string is moved purely in the longitudinal direction, the rollers will stay in the position as shown in Figure 7 so that they may freely rotate to reduce longitudinal friction. It will be appreciated that when there is a combination of rotational and axial movement the axis of the rollers will be somewhere between the two positions described above.

Referring to figures 10 to 12 a third embodiment will be described. The fitting of the third embodiment comprises an inner section 30 and an outer section 31 which is rotatable about inner section 30. Inner section 30 is adapted to be secured about a drill pipe which passes through bore 32. Inner section 30 may be of two part construction (similar to that shown in figure 3) where the two parts are secured together by bolts or similar fastening means. Outer section 31 may similarly be of two part construction and be secured about inner section 30. Outer section 31 is provided with a plurality of fins 33 extending radially from body 34.

Figure 11 shows a cross-sectional view along the axis of the fitting shown in figure 10. In this case the fitting is secured to a drill pipe 35. A layer of friction reducing material 36 is provided between faces 42 to 47 to reduce friction as outer section 31 rotates about inner section 30. Layer 36 will preferably be formed of a plastics material such as nylon (zytel 70633L for example).

Seals 37 and 38 are provided at either end of the bearing formed by the inter-engaging faces 42 to 47 of inner section 30 and outer section 31 and friction reducing layer 36. These seals serve to prevent the ingress of fluid from a well into the bearing. This greatly reduces friction on bearing surfaces, thus reducing wear and decreasing the torque required to drive a drill string.

Due to the sealed nature of the bearing a pressure compensating system 39 is provided to compensate the pressure within the bearing as the external pressure varies. The pressure compensating system comprises a diaphragm 40 containing grease within region 41 which moves in and out of the bearing as external pressure varies. This prevents external fluid being drawn into the bearing as the external pressure increases.

The bearing journals 42 and 43 are preferably precision ground. Bearing sleeves may be provided if required. Sections 44 and 45, and 46 and 47 of the bearing minimise friction when the outer section 31 is forced in the axial direction relative to the inner section 30.

Referring now to figure 12, seal 37 is shown in detail. The seal is seen to include a resilient seal 48 located within a recess 49 in outer section 31.

Seal 48 is preferably formed of a fibre reinforced PTFE.

The profile of the fins 33 is shown to be semi-circular in figures 10 and 11. It is to be appreciated that other profiles may be employed which reduce drag in the axial direction. The curved profile shown is preferred due to its drag reduction in both directions. It is to be appreciated that rollers could be provided upon fins 31 to assist in the reduction of axial drag. The fins are preferably coated with a ceramic coating such as CERAM-KOTE™.

Bearing surfaces 42 to 47 are preferably coated with a hard material such as Technogenia "technopoudre" or similar. Channels are preferably provided in bearing surfaces 42 and 43 to facilitate the flow of lubricant. These channels will preferably be semi-circular in profile and will preferably spiral along the length of the journals (similar to the recesses 6 shown in figure 2).

This fitting may be mounted directly onto a drill pipe during production or may be retrofitted to an existing drill pipe. Alternatively, the fitting may be provided on its own separate "sub" or mandrill, in which case the "sub" or mandrill may be screwed into the drill string between two lengths of drill pipe.

It will thus be seen that the invention provides a number of simple inexpensive fittings for reducing the friction experienced between a drill string and the wall of a well. The fittings may be used to protect the joints of pipe strings or fitting tools as required. The invention reduces friction and thus the required torque to drill a well. Reduction of friction also reduces drill string vibration and thus

fatigue in the drill string. The invention also minimises environmental damage by using a water-based mud lubricant.

Where in the foregoing description reference has been made to integers or components having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof, it is to be appreciated that improvements and/or modifications may be made thereto without departing from the scope of the invention as defined in the claims.

Industrial applicability

The present invention may find particular application in the reduction of friction experienced by drilling strings.

CLAIMS:

1. A fitting for reducing friction between a fitting and a section of a drill string or further fitting on a drill string, said fitting comprising a body having a tubular bore provided with a plurality of longitudinally extending recesses spaced circumferentially about the bore, dimensioned to lubricate the interface between the fitting and the drill string or further fitting with fluid in a drilling well.

2. A fitting as claimed in claim 1 wherein the bore of the fitting is polygonal in cross-section.

3. A fitting as claimed in claim 1 or claim 2 wherein the recesses spiral along the length of the bore.

4. A fitting as claimed in any one of the preceding claims wherein rollers are provided about the periphery of the body to reduce friction in the axial direction.

5. A fitting as claimed in claim 4 wherein rollers are provided in banks about the circumference of the body.

6. A fitting as claimed in claim 5 wherein each bank of rollers includes a protective mounting assembly which exposes only a portion of each roller.

7. A fitting as claimed in any one of the preceding claims wherein the fitting is of two part

construction adapted to be secured about a drill string.

8. A fitting as claimed in any one of the preceding claims wherein a filtering means is provided at either end of the fitting to prevent debris entering the longitudinal recesses.

9. A fitting as claimed in any one of the preceding claims in combination with a sleeve having collars at either end adapted to be secured to a section of drill pipe with the fitting secured thereabout between said collars.

10. A fitting as claimed in claim 1 having a bore of substantially circular cross section in combination with a sleeve for securement to a section of drill pipe wherein the sleeve has a substantially polygonal cross-section.

11. A fitting for engagement to a drill string or further fitting having a body with a bore therethrough provided with a plurality of roller means on the exterior of the body, said roller means being rotatable relative to the body about an axis transverse to the axis of the bore, the arrangement being such that the roller means can rotate relative to said body to facilitate reduction of rotational and axial friction.

12. A fitting as claimed in claim 11 wherein the roller means includes rollers positioned away from the transverse axis so as to rotate said roller means to keep the axis of said rollers substantially transverse to the direction of movement.

13. A fitting as claimed in claim 12 wherein a plurality of rollers are provided on each said roller means.

14. A fitting as claimed in any one of claims 11 to 13 wherein the roller means comprises a substantially disc-shaped member located within a corresponding recess in the body.

15. A fitting as claimed in claim 14 wherein said disc-shaped member includes a central bore which locates with a pin extending outwardly from said body.

16. A fitting as claimed in claim 14 or 15 wherein a plate is secured above the peripheral edge of each roller means to retain it within its recess.

17. A fitting as claimed in any one of claims 11 to 16 wherein the rollers are formed of a nylon or ceramic material.

18. A fitting a claimed in any one of claims 11 to 17 wherein the rollers have a substantially tapered cylindrical form and rotate about an axis transverse to the axis of rotation of the roller means.

19. A fitting as claimed in any one of claims 11 to 18 wherein the body is of two part construction so that it may be secured about a section of drilling pipe.

20. A fitting for engagement with a drill string or further fitting comprising an inner section for securement to a drill string or further fitting and an outer section secured about said inner section and rotatable relative thereto about a drill string.

21. A fitting as claimed in claim 20 wherein a sealed bearing is provided between the inner and outer sections.

22. A fitting as claimed in claim 20 or claim 21 wherein a layer of friction reducing material is provided between the inner and outer sections.

23. A fitting as claimed in claim 22 wherein the layer of friction reducing material is formed of a plastics material.

24. A fitting as claimed in claim 23 wherein the plastics material is nylon.

25. A fitting as claimed in any one of claims 21 to 24 wherein seals are provided on either side of the friction reducing layer between the inner and outer sections.

26. A fitting as claimed in any one of claims 21 to 25 wherein a pressure compensating means is provided to maintain the pressure within the bearing substantially the same as the external pressure.

27. A fitting as claimed in any one of claims 20 to 26 wherein a plurality of fins project radially from said outer section which are profiled to reduce drag in the axial direction.

28. A fitting as claimed in claim 27 wherein the fins have a curved profile.

29. A fitting as claimed in any one of claims 20 to 28 wherein rollers are provided on the periphery of said outer section to reduce friction in the axial direction.

30. A fitting as claimed in any one of claims 21 to 26 wherein the bearing comprises first journal surfaces on said inner and outer sections in the axial direction of said fitting and second and third journal surfaces on said inner and outer sections extending radially outwards to restrict movement of said outer section relative to said inner section in the axial direction.

31. A fitting as claimed in any one of the preceding claims constructed in such a manner as to allow the fitting to be rebuilt or reconditioned.

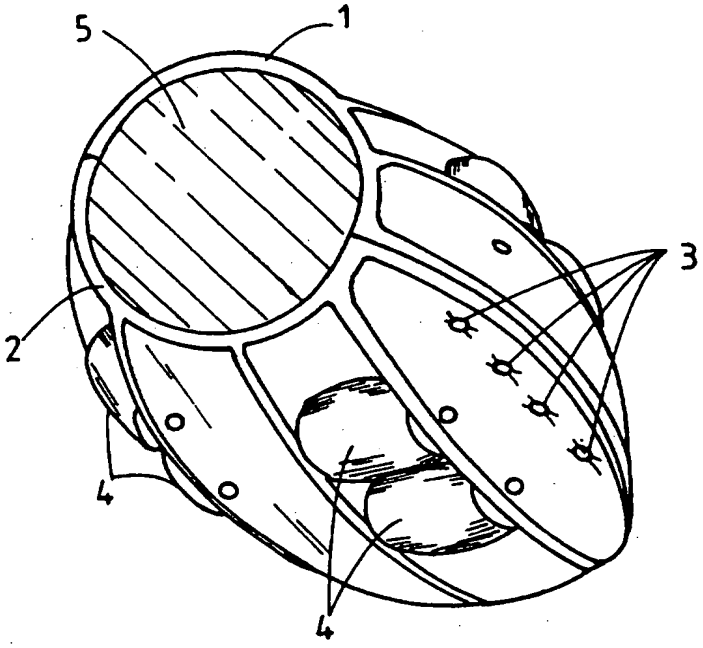

FIG. 1

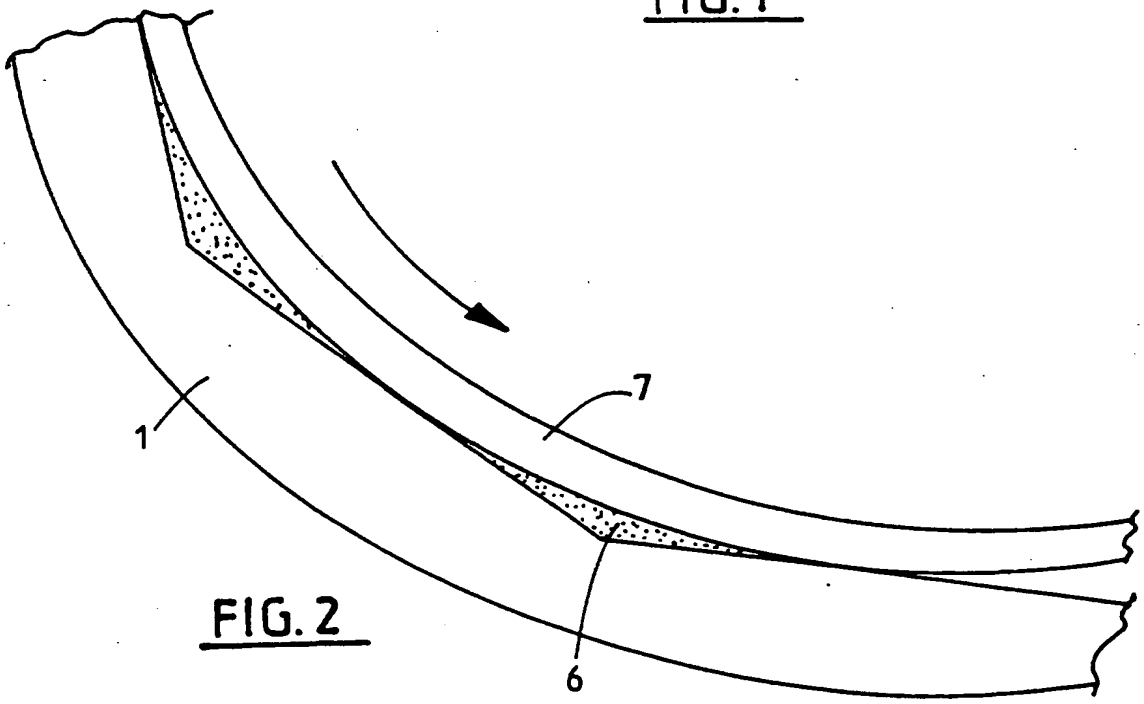

FIG. 2

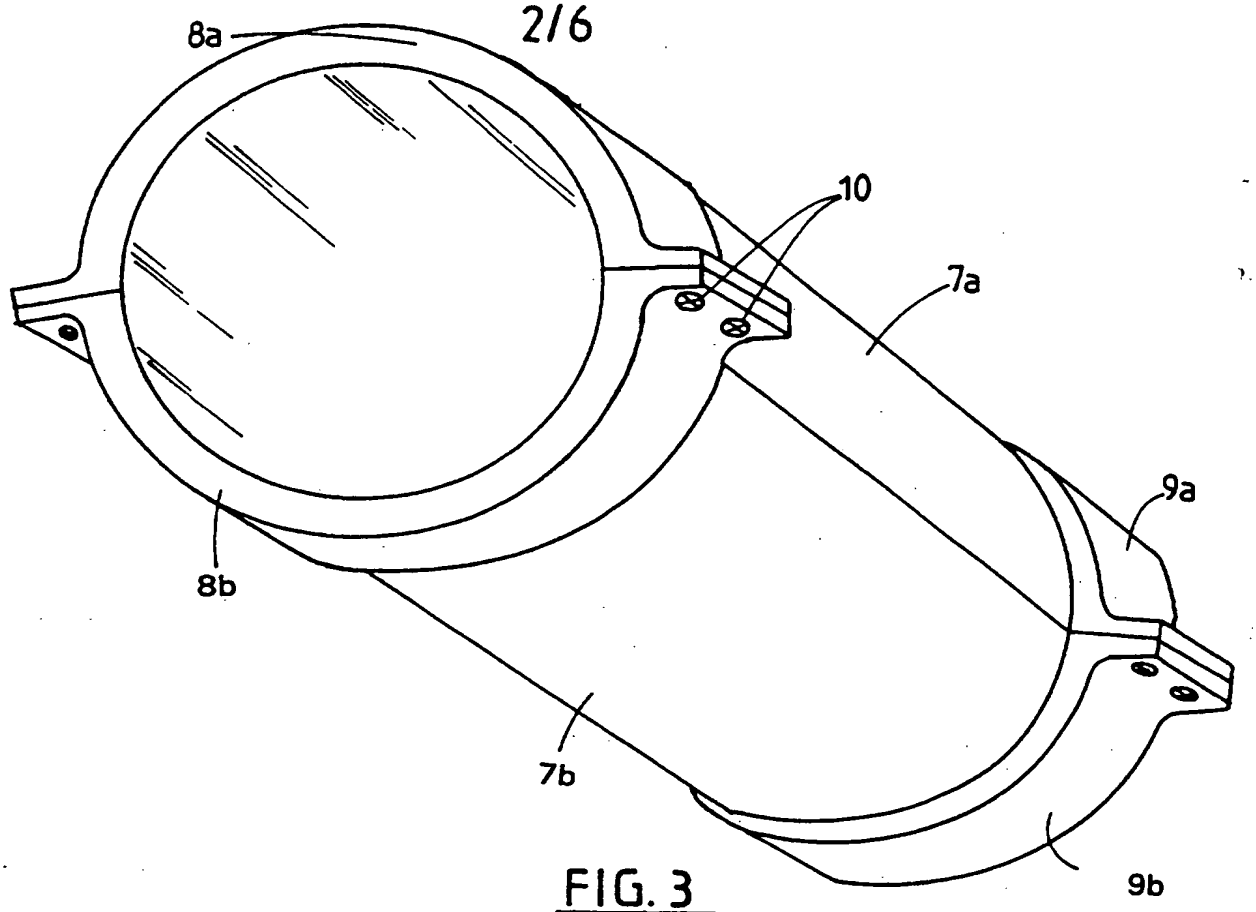

FIG. 3

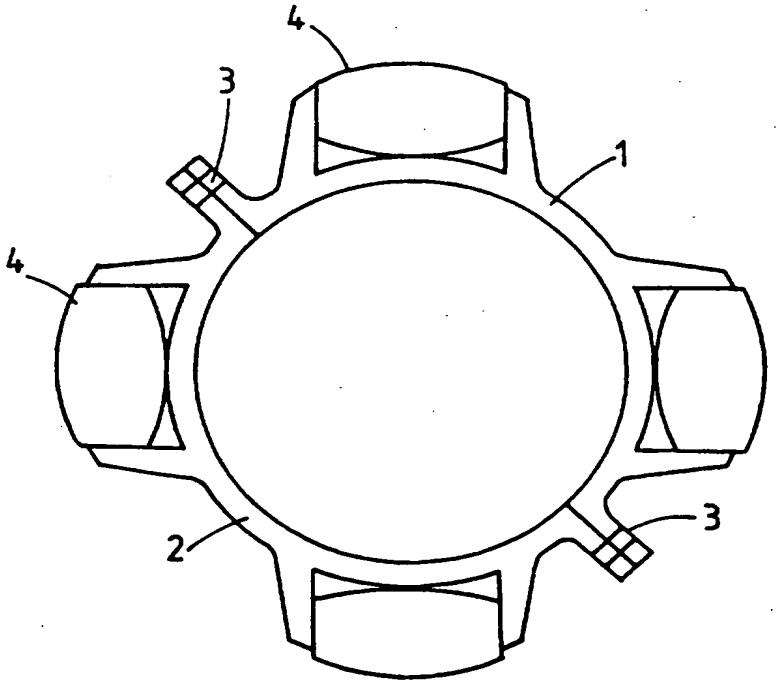

FIG. 4

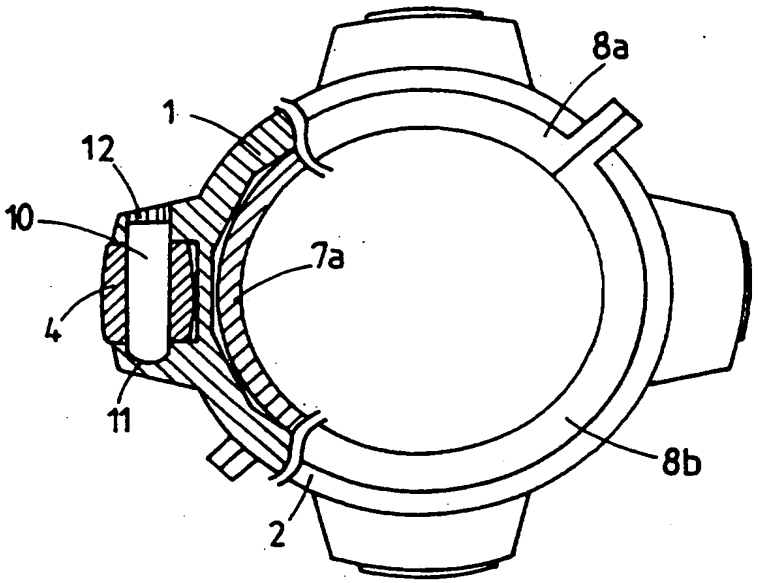

FIG.5

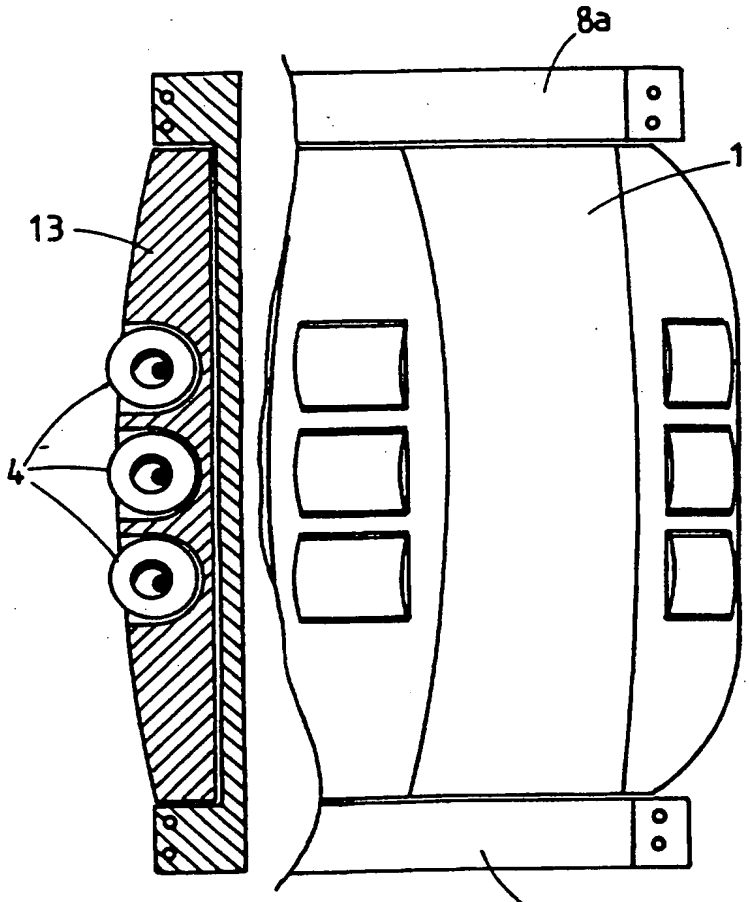

FIG.6

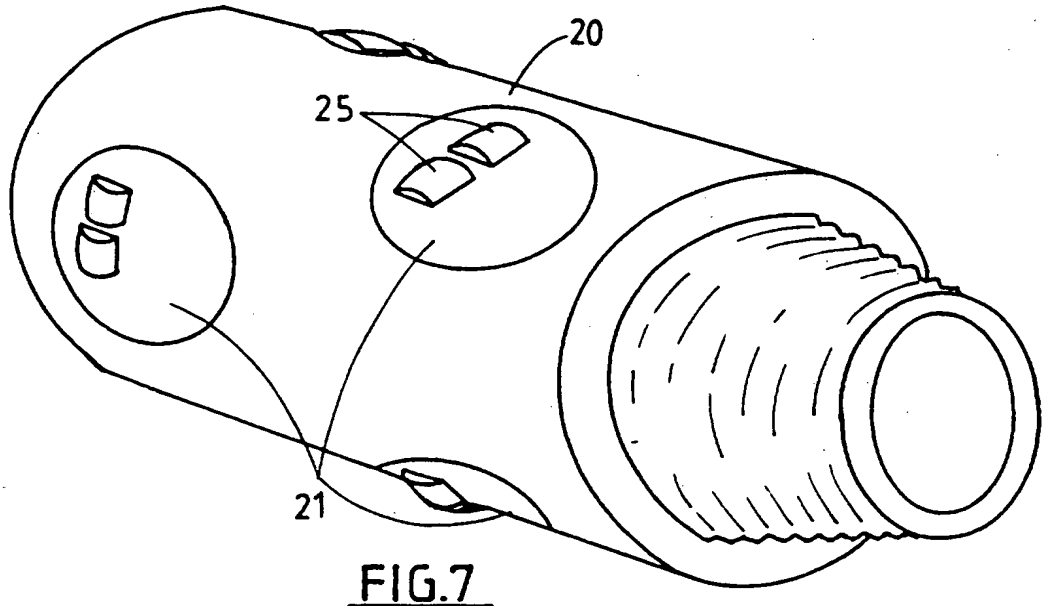

FIG.7

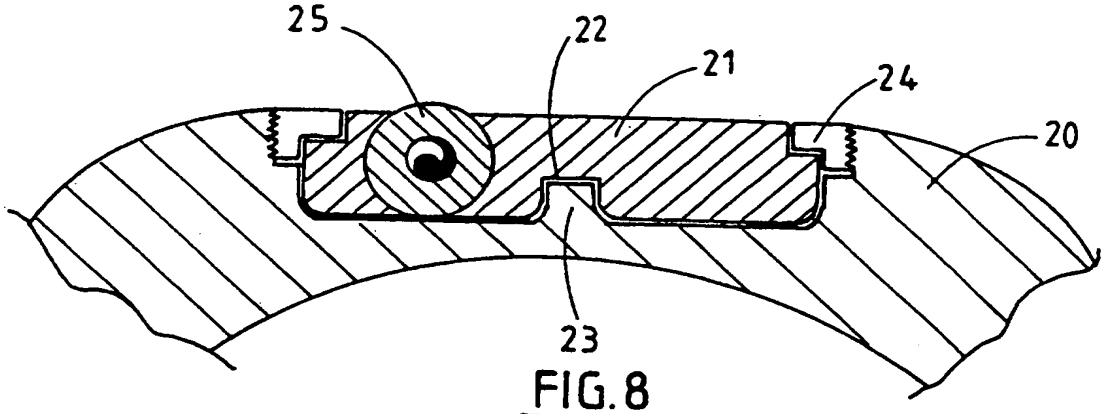

FIG.8

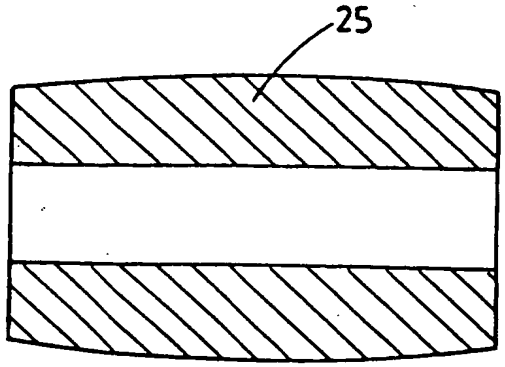

FIG.9

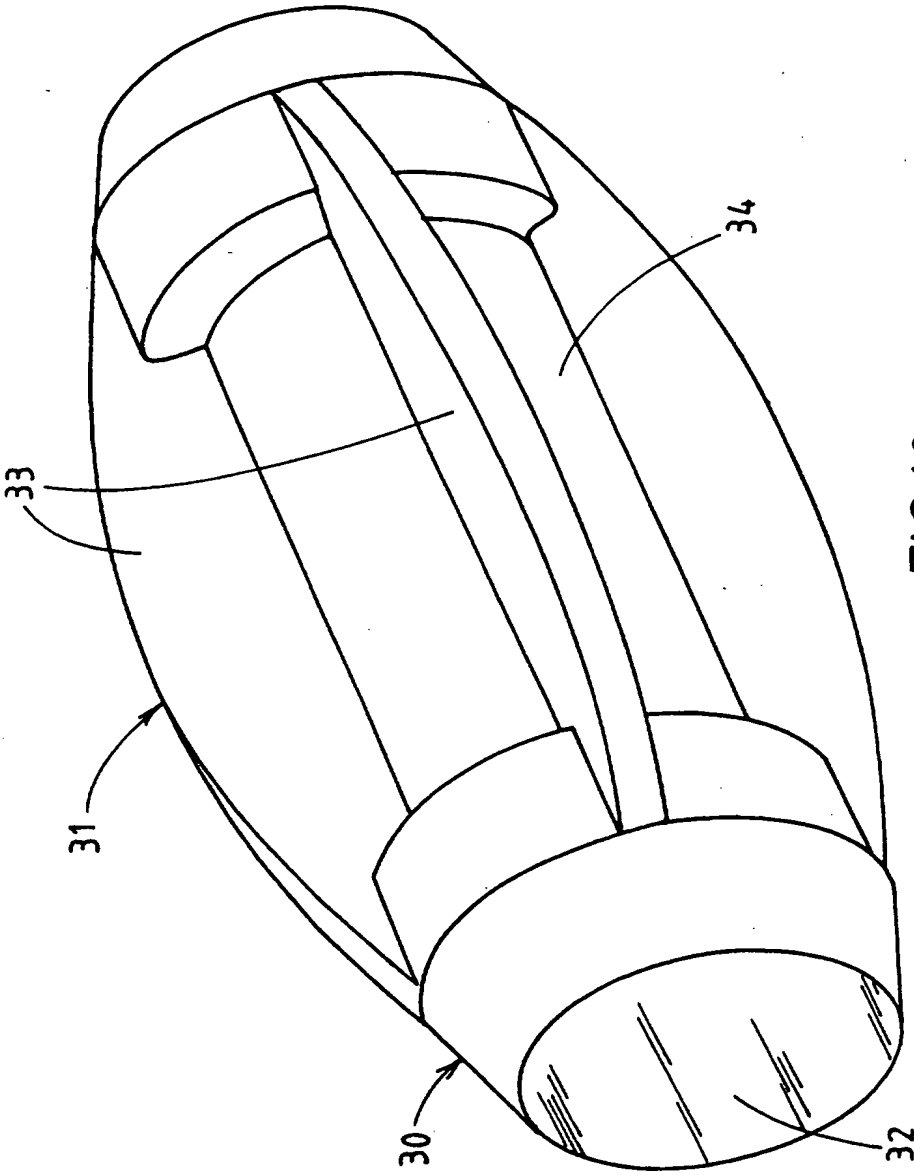

FIG.10

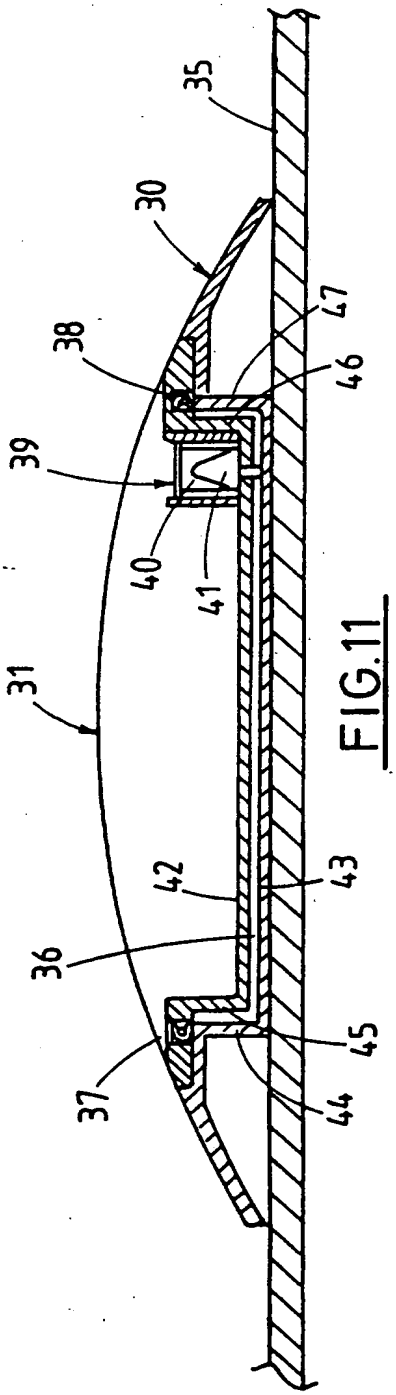

FIG.11

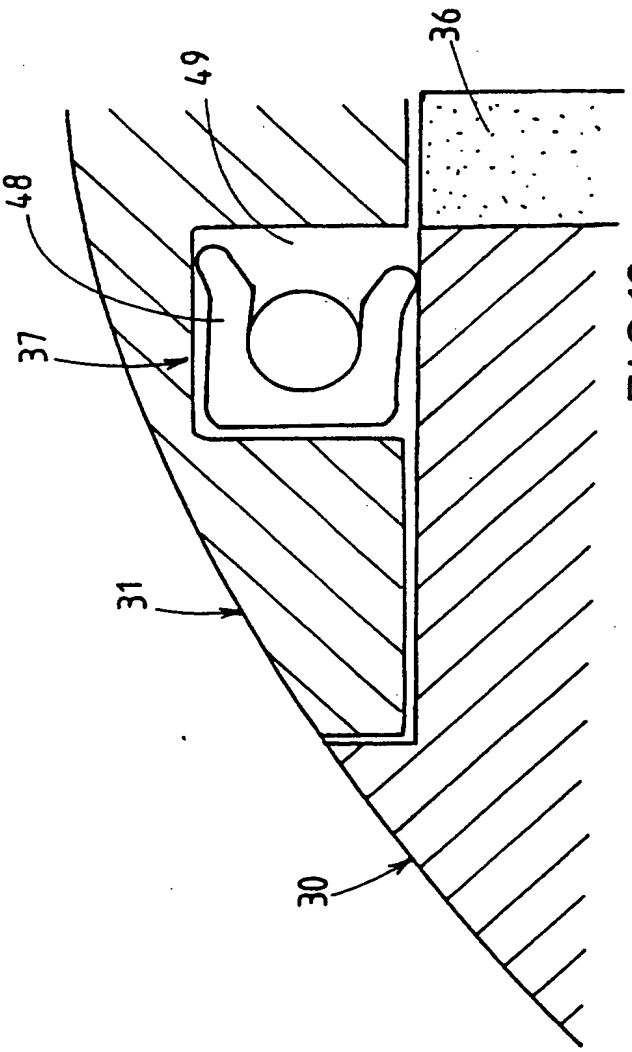

FIG.12

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 96/00034

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: E21B 17/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC[6]: E21B 17/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 3410613 A (KUUS), 12 November 1968 See entire document	1-3 4-10
X Y	US 1905158 A (CRAIG et al.), 25 April 1933 See entire document	11-15 16-19
X Y	US 1651088 A (FENTRESS G E, ISAACS H H), 29 November 1927 See entire document	20-26

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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26 August 1996

Date of mailing of the international search report
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PCT/INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 96/00034

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	GB 2233690 A (THE RED BARON (OIL TOOLS RENTAL) LIMITED) 16 January 1991 See entire document	20-26 27-31
X Y	GB 271839 A (US TOOL COMPANY), 29 March 1928 See entire document	11-15, 20-26 16-19, 27-31
X	EP 333450 A (ANDERSON, C A), 20 September 1989 See entire document	11-15
P,X	WO 95/21986 A (AUSTOIL DRILLING SERVICES PTY LTD) 17 August 1995 See entire document	11-19
X Y	WO 95/10685 A (ROTOTEC LIMITED), 20 April 1995 See entire document	20-26 27-31
X	GB 2275284 A (SPEIRS), 24 August 1994 See entire document [Abstract only available]	11-15
X	Derwent Abstract Accession No. 55981B/30, Class H01Q 49, SU 627230 (BORING TECH RES INS) 11 September 1978	11-15
X	Derwent Abstract Accession No. 94-224135/27, Class Q49 SU 1810474 A (TYUMEN IND INST) 23 April 1993	11-15
X	Derwent Abstract Accession No. 94-348318/43, Class Q49 SU 1821548 A (UKR NAT GASES RES INST), 15 June 1993	11-15
X	Derwent Abstract Accession No. 04193 K/02, Class Q49 SU 911007 A (BASHKIR PETROIND), 10 March 1982	11-15
X	Derwent Abstract Accession No. 84-286695/46, Class Q49 SU 1016475 A (PARKHOMENKO V F), 7 May 1983	20-26
X	Derwent Abstract Accession No. 71801E/34, Class H01Q 49 SU 874947 A (SAKHALIN GAS IND), 28 October 1981	11-15

INTERNATIONAL SEARCH REPORT

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Box 1 Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1 Claims 1-3, 10
Fitting for a drill string with recessed bore for reduced friction between fitting and drill string.

2 Claims 4-9, 11-31
Fitting for a drill string with roller means on periphery of fitting to reduce notational and axial friction of fitting. (As reasoned on extra sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

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Box Box II (continued)

The International application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are two inventions:

1 Claims 1-3 and 10 directed to a fitting for reducing friction between a fitting and a section of a drill string whereby the tubular bore of the fitting which houses the drill string has a plurality of longitudinally extending recesses spaced about the bore to enable lubrication between the drill string and the fitting. It is considered that such a recess to enable lubrication between both surfaces comprises a first "special technical feature".

2 Claims 4-9 and 11-31 directed to a fitting for engagement to a drill string having a bore therethrough to house the drill string but employing a series of rollers or rotatable outer surfaces on the exterior of the body of the fitting to reduce rotational and axial friction in the fitting. Claims 4-9 although appended to claim 1 are also defined by employing rollers or the like on the periphery of the body of the fitting. It is considered that such external rollers/rotatable surfaces are considered to comprise a second separate "special technical feature".

Since the abovementioned groups of claims do not share either of the technical features identified, a "technical relationship" between the inventions, as defined in PCT Rule 13.2 does not exist. Accordingly the International application does not relate to one invention or to a single inventive concept.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
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This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	3410613	GB	1157044	NL	6707285		
GB	2233690	AU	59421/90	CA	K2058956	EP	479927
		NO	915123	US	5261498	WO	9100411
EP	333450	CA	1335500	NO	891101	US	4958692
WO	9521986	AU	17201/95				
WO	9510685	AU	78206/94	CA	2173864	EP	721539
		NO	961472				

END OF ANNEX